Insulation resistance tests with

MEG-CHEK®

Model
2201

MP MASTER
MA30052

MANUAL 17456

ASSOCIATED RESEARCH, INC.
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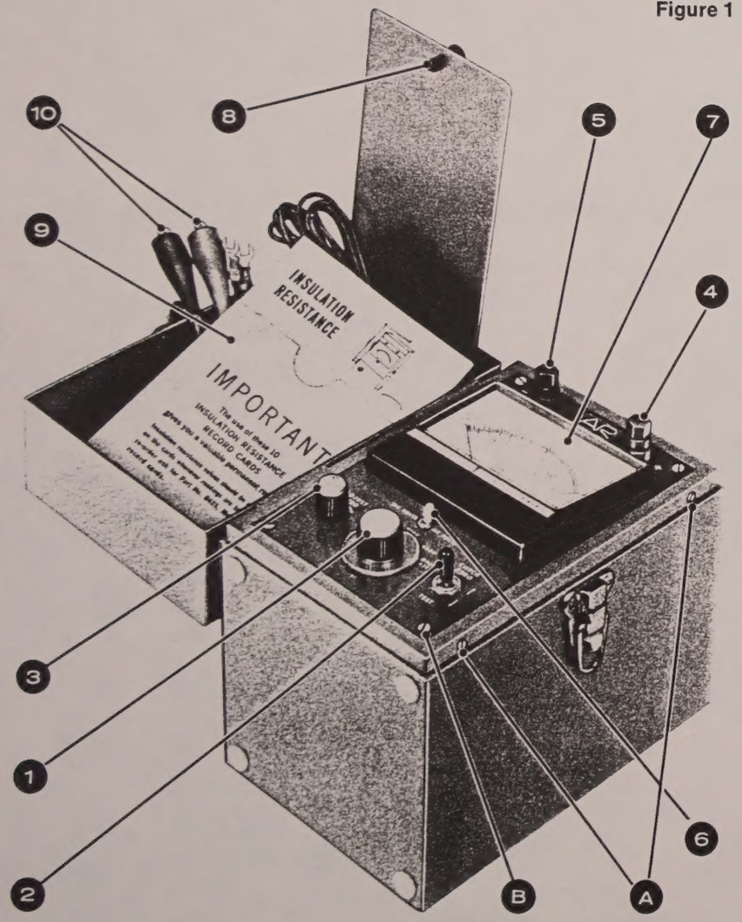
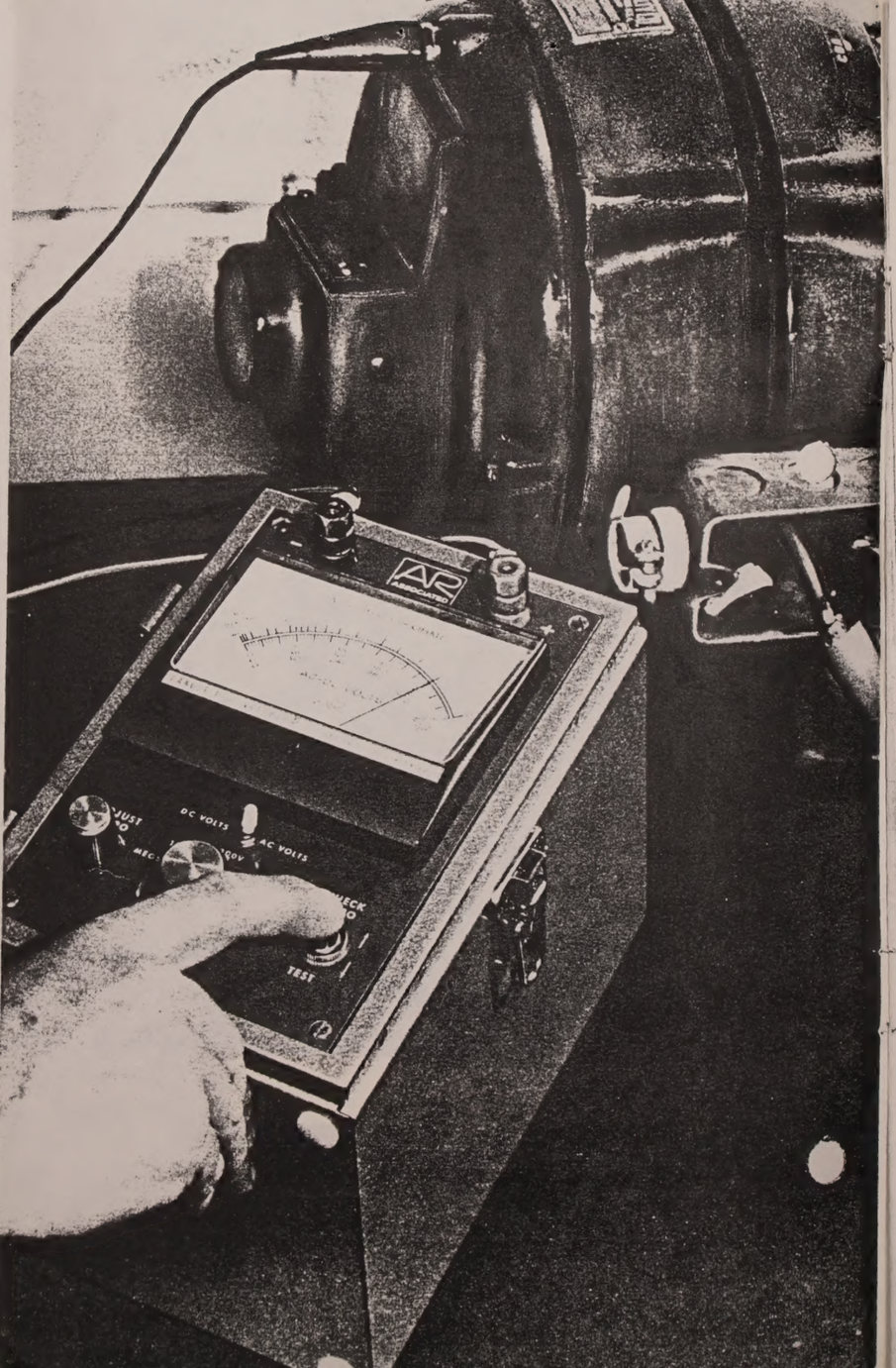
Lift flap for figure 1

Figure 1



1. Range Selector Switch
2. Lever Switch
3. Adjust Zero
4. Positive Test Terminal
5. Negative Test Terminal
6. AC-DC Volts Selector Switch
7. Meter
8. Cover Compartment Latch
9. MEG-CHEK Record Cards
10. Test Leads

A. Screws (4) holding panel assembly to cabinet.
B. Screws (4) holding control panel (see Figure 15).



MEG-CHEK

Megohmmeter... a 3-in-1 instrument

Measures megohms, ohms, AC/DC volts

The combination MEG-CHEK models covered by this Manual are designed to provide maintenance engineers a convenient single instrument for performing general electrical maintenance measurements of wiring, motors, generators, switchgear, circuit breakers, transformers and related electrical equipment. The megohm ranges measure insulation resistance, the ohm ranges measure circuit or winding resistance and the voltmeter ranges measure connected line or other circuit voltages.

MEG-CHEK is the new trademark for the re-engineered solid-state megohmmeters designed by Associated Research.

Since their original development in 1939, AR megohmmeters using synchronous vibrator power supplies to generate 500 and 1000 VDC testing potentials have been marketed under the VIBROTEST trademark.

The new name MEG-CHEK more accurately describes the function of these instruments and will from now on symbolize the quality of construction, accuracy of measurement and ruggedness of instrument for which all AR testing equipment is known.

The following seven Meg-Chek models are covered by this manual at the time of publication:

Model	Megohm Range	DC Test Volts	Ohm Range	Voltmeter Ranges	
				AC	DC
2201	0-200	500	0-2000	0-150/300/600	0-150/300/600
2204	0-200	1000	0-2000	0-150/300/600	0-150/300/600
2205	0-200	500	0-20,000	0-150/300/750/1500	0-150/300/750/1500
2208	0-200	500	0-2000/200K	0-150/300/600	0-150/300/600
2211	0-200/2000	1000	0-200,000		
2224	0-100/1000	500	0-10,000		
2225	0-100/1000	400	0-10,000		

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BATTERY POWERED MEG-CHEK® SIMPLIFIED SCHEMATIC OF INSULATION RESISTANCE MEASURING CIRCUIT

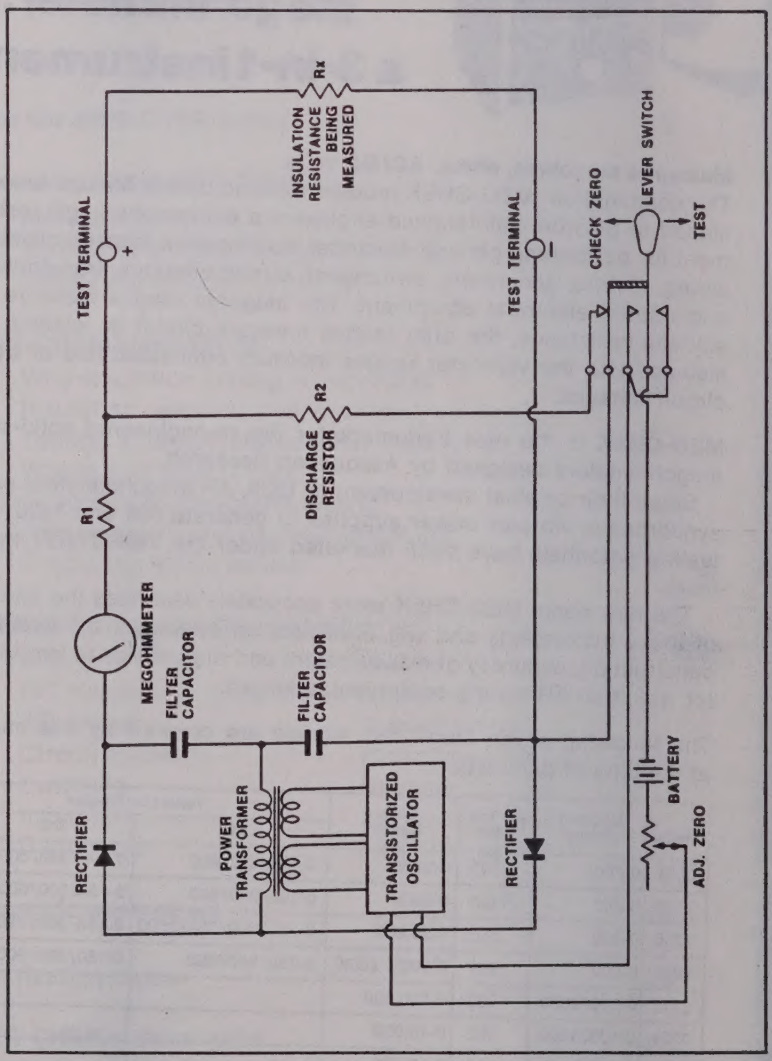


Figure 2

MEG-CHEK Introduction

The Megohm range of the MEG-CHEK provides a direct reading of the millions of ohms (megohms) of resistance which any electrical insulation offers to the passage of current. It is common practice to measure this resistance with a test potential of 500 volts, though lower and higher voltages are also frequentiy used.

This relatively high test voltage (500 volts in most models of the MEG-CHEK) is produced by a battery powered transistorized oscillator power supply. The three volts supplied by two heavy duty dry cells is converted to AC in the oscillator circuit, stepped up to a higher voltage in the power transformer, and then rectified and filtered to produce the direct voltage appearing across the measuring terminals.

When the Lever Switch (Figure 2) is pushed to the CHECK ZERO position, the Battery and the ADJUST ZERO potentiometer are connected to the input of the Oscillator, while the Meter and Resistors R-1 and R-2 are connected across the Power Supply to measure the output voltage. The ADJUST ZERO control regulates the input to the Oscillator and consequently the output voltage as well. When the control is adjusted so that the Meter pointer rests at full scale (zero resistance mark), the rated test voltage is available from the Power Supply. When the Lever Switch is operated to the TEST position, the Battery and ADJUST ZERO potentiometer are again connected to the Oscillator input. However, the metering circuit is re-connected so that it is in series with the unknown insulation resistance Rx connected across the Test Terminals. Since the Power Supply has been adjusted for the rated output voltage, the current flowing in the metering circuit will now be determined by the value of the unknown insulation resistance Rx. Therefore, the Meter deflection is also determined by this value and the Meter scale may be calibrated directly in terms of megohms.

When the insulation resistance Rx has been measured and the Lever Switch released, discharge Resistor R-2 (which is of comparatively low value compared to the insulation resistance being measured) is connected across the Test Terminals to discharge any voltage stored in the capacitance of the item under test.

Some models of MEG-CHEK have an external Guard connection so that unwanted leakage current may be bypassed around the metering circuit when making megohm measurements.

Many models of MEG-CHEK have additional circuitry to permit measurement of low resistance or AC or DC voltages. Both the AC and DC voltage ranges have sensitivities of 1,000 ohms per volt. The AC voltage ranges have an accuracy of ± 3% of full scale when measuring standard 60 Hz voltage. Unlike many instruments the MEG-CHEK indicates AC voltage on an easy reading linear scale. The DC voltage ranges have an accuracy of ± 2% of full scale value.

Most MEG-CHEK models also have one or more ohm ranges which are particularly useful when measuring the relatively low resistance of circuits in motors, relays, or control box coils. The low range ohmmeter is powered directly by the 3 volt battery source.

Since battery drain is low during operation and current is required only when the Lever Switch is operated to measure Megohms or Ohms, the batteries last many months, even under conditions of extreme use.

Caution

When handling the MEG-CHEK, remember that there is a high voltage across the terminals when testing in the megohm range. Very low current flow makes the MEG-CHEK relatively safe, even when improperly used; but it is best to be sure that no one inadvertently comes in contact with the test circuit.

OPERATION OF THE MEG-CHEK

Open the case of the MEG-CHEK and examine the instrument carefully, using the photo diagram (Figure 1, on front cover fold-out) of this manual to identify the various parts and to establish their functions firmly in mind.

While the operating instructions in the cover of the instrument are adequate for making tests, it is urgently recommended that you carefully read the paragraphs that follow before actually using the instrument. These instructions and application suggestions are a general introduction to insulation resistance testing as well as a more detailed set of operating instructions.

The cover of the MEG-CHEK may be removed by opening it fully, then, while working it gently, push it towards the top of the instrument. The pin hinges will slide out of their sockets in the case, leaving the MEG-CHEK ready for operation.

Before connecting the test leads to the terminals, practice operating the MEG-CHEK for several "dry runs" to become familiar with the use of the Selector Switch, Lever Switch, and the ADJUST ZERO control. Complete understanding of the instrument and its adjustments will save you time and insure accurate test results later.

Turn the Range Selector Switch (1) to the extreme counter-clockwise position, marked MEGS. With your right hand push the Lever Switch (2) up to the CHECK ZERO position. The Meter pointer will swing to the extreme right end of the megohm scale. If the pointer does not come to rest exactly at zero rotate the ADJUST ZERO control (3) with your left hand in the direction the pointer should move to reach zero. After the Meter is zeroed release the Lever Switch and then move it down to the TEST position. This will apply the correct test potential across the Test Terminals (4 & 5) of the instrument. Since the resistance across the terminals without the leads connected is, of course, infinity, the Meter pointer will rest on the infinity mark, at the extreme left end of the scale.

Now try the same procedure but with the Range Selector Switch (1) in the OHMS (extreme clockwise) position. You will notice that the operation of the Lever Switch and the ADJUST ZERO control are the same as before.

You will also notice that you cannot switch directly from MEGS to OHMS. This is a built-in safety device to warn you to check circuits to be tested for voltage before measuring either OHMS or MEGOHMS. Turning the Range Selector Switch through the Voltage Ranges is a simple, mechanical reminder which can save you time and trouble.

It is not necessary to operate the Lever Switch (2) or the ADJUST ZERO control (3) when making voltage measurements. Simply turn the Range Selector Switch (1) to the proper Voltage Range and operate the AC/DC Volts Selector Switch (6) to the proper position for the test.

MEASURING VOLTAGE

Operate the AC/DC Volts Selector Switch (6) to the desired position and rotate the Range Selector Switch (1) to the desired Voltage Range. In general it is desirable to read voltage in the upper portion of the scale for increased accuracy, so the range selected should be one that is higher than, but close to the expected voltage reading. If uncertain as to the voltage, start on the highest range and switch to lower ranges, if necessary, to get the best reading.

Attach the leads to the Terminals; the red lead to the + Terminal (4) and the black lead to the − Terminal (5). Connect the black lead clip to the grounded side of the circuit or to the negative line when measuring DC, and the red lead to the hot side (or positive line). Since an energized circuit is being measured, take extreme precautions to handle the leads by the insulated clips only, using only one hand at a time, keeping the other hand free and clear of any other circuit, terminal or ground. If possible, it is preferable that the switch be opened so that the connections may be made to the de-energized circuit. Readings can then be taken when the switch is closed after the connections to the instrument have been made.

Be certain that polarity is correct when measuring DC voltages. With the leads connected improperly (reverse polarity) the meter will not indicate the voltage.

Both AC and DC voltages are indicated on the linear AC-DC volts scale located directly below the megohm scale.

After making the voltage measurement, again take extreme care in disconnecting the leads from the energized circuit, or preferably, de-energize the circuit before disconnecting.

INSULATION RESISTANCE MEASUREMENTS (MEGOHMS)

This test is made to determine the resistance value of the insulation between two isolated circuits. While usually there is insulation between a current carrying circuit and a non-current carrying or ground metallic path, equipment frame or other ground, the insulation resistance between two separate current carrying circuits is also fre-

quently of importance (for example: between the separate conductors of a multi-conductor cable).

1. Set Range Selector Switch (1) to highest Voltage Range. Switch AC-DC Volts Selector Switch (6) to AC.
2. Attach leads to Terminals; red lead to + Terminal (4); black lead to − Terminal (5).
3. Connect test lead clips to the appropriate points on the equipment to be tested.
4. Check for presence of voltage by rotating the Range Selector Switch down through the Voltage Ranges. If voltage is present, determine its source and eliminate it before attempting to check insulation resistance.
   Never start a megohm test if there is any external voltage in the test circuit.
5. Set Range Selector Switch (1) to MEGS position.
6. Operate Lever Switch (2) to CHECK ZERO, and adjust meter pointer on zero (extreme right) with ZERO ADJUST control (3).
7. Push down Lever Switch (2) to TEST, and start timing test. Unless you are testing for polarization index,* a 60 second test will, in most cases, be adequate to give a satisfactory indication of insulation resistance value. If you make tests with different lengths of time for different pieces of equipment, enter test times on the MEG-CHEK Record Card. (see page 13)
8. Read Megohms as indicated on the MEGOHMS scale of the meter. When the Lever Switch (2) is released to center position, any capacitive charge in the tested circuit is dissipated through a discharge resistor incorporated in the MEG-CHEK.
9. Take temperature and humidity readings and enter them on the Record Card, with megohm reading and date of test. If it is impossible to keep accurate temperature and humidity records, equivalent test conditions can be approximated by making each test on a given piece of equipment under conditions as identical as possible.
10. Set Range Selector Switch (1) to highest Voltage Range upon completion of test.
11. Disconnect leads and stow in cover.
12. Reassemble cover to case, close cover, and latch.

*See page 24

MEASURING RESISTANCE (OHMS)

1. Set Range Selector Switch (1) to highest Voltage Range. Switch AC-DC Volts Selector Switch (6) to AC.
2. Attach leads to Terminals; red lead to + Terminal (4); black lead to − Terminal (5).
3. Connect the test lead clips to the appropriate points on the equipment to be tested. Since this measurement is for continuity, or ohms, both test leads have to be connected to different points on the same circuit.
4. Check for presence of voltage by rotating the Range Selector Switch down through the Voltage Ranges. If voltage is present, determine its source and eliminate it before attempting to check resistance. If there are any capacitors in the circuit make sure they are completely discharged before proceeding.
5. Set Range Selector Switch (1) to OHMS position.
6. Operate Lever Switch (2) to CHECK ZERO, and adjust meter pointer to zero (extreme right) with ADJUST ZERO control.
7. Operate Lever Switch (2) to TEST, read Ohms resistance—the Megohms scale is used for reading Ohms by applying the multiplying factor indicated by the position of the pointer on the Range Selector Switch.
8. Upon completion of test, set Range Selector Switch (2) to highest voltage range.
9. Disconnect test leads and stow in cover.
10. Reassemble cover to case, close cover, and latch.

MEG-CHEK Applications

Insulation covering the various pieces of electrical equipment and wiring in your plant or product is, to all appearances, inert. Its dielectric properties (resistance to electrical current flow) are the reason for its use; and since good dielectric materials are also generally good wearing materials, the problem of weakening or faulty insulation resistance may, unfortunately, easily be overlooked until valuable equipment or critical wiring systems fail in use.

Electrical insulation is subject to severe stresses, even under ideal operating conditions. These stresses, which cause progressive weakening of insulation value, are caused by electrical stresses, heat, dirt, moisture, vibration, wear, aging, and even by light. The operating cycle of an electric motor gives good examples of these stresses. When a cold motor is started, its insulation is also cold. As the motor heats, so does the insulation, expanding under the temperature rise... and contracting again when the motor is shut off. You have seen the vast power exerted by water freezing in a confined space—bursting iron pipes, automobile radiators and engine blocks as though they were paper. This same force is present, in varying degrees, in all heated-and-cooled materials. It creates strains on insulation that frequently result in breaks, which cause direct short circuits or serious power losses.

Dirt is another great enemy of insulation because almost all dust, lint, airborne grease, etc., are good conductors, and are capable of penetrating minute cracks and faults in electrical insulation. Keeping electrical equipment clean is of primary importance for good preventive maintenance—and testing with the MEG-CHEK is the best means of detecting hidden dirt in electrical machinery and wiring.

Again, using a motor as an example, let us assume that it operates in a damp atmosphere, such as encountered in many processing plants, paper mills, and the like. As the motor warms up it heats the air around it, causing the air to absorb more moisture...and a part of this moisture is absorbed by the insulation in the windings. On cooling, this moisture condenses in the insulation, and adds to the expansion-contraction effects in deteriorating the insulation. Even a damp, high humidity day creates this effect, lowering the insulation resistance of all electrical equipment—as you will discover when you MEG-CHEK your equipment on such a day. Of course, flooding or other accidental immersion of electrical equipment calls for special treatment in drying and cleaning.

Vibration is an ever-present hazard to insulating materials. It is created by operating machinery, steam lines, or even pedestrian traffic. Insulation is subject to the same results from vibration as the old automobile that "actually shook itself to pieces."

Wear, aging and light deterioration are generally less severe than damage caused by dirt, water, heat and vibration. Their effect on electrical insulation is relatively slow, but nonetheless sure.

Because of these natural "enemies" of insulation, it is good practice to periodically check electrical equipment with a MEG-CHEK. Such checks show present faults and may predict the breakdown or dangerous weakening of your electrical systems, or any piece of equipment.

Safe insulation resistance in rotating machinery or other equipment may be regarded as that which is high enough to permit the equipment to operate normally...without excessive current consumption or heating. This is the simplest, most obvious rule to follow. Generally, you can consider most insulation in industrial equipment and circuits operating at 1,000 volts or less satisfactory if its resistance exceeds two megohms at normal operating temperatures and humidities.

INSULATION RESISTANCE VS. OPERATING VOLTAGE

IEEE publication No. 43 (RECOMMENDED GUIDE FOR TESTING INSULATION RESISTANCE OF ROTATING MACHINERY) suggests that the minimum acceptable insulation resistance be calculated as follows: Rm = KV + 1.

Where:

Rm = recommended minimum insulation resistance in megohms, at 40° C.

KV = rated potential in kilovolts (1,000 volts = 1 kilovolt).

Rm at 40° C. is therefore one megohm per 1,000 volts plus one megohm.

If the insulation resistance readings fall below this minimum, equipment should be taken out of service, inspected carefully, and necessary cleaning or repairs made to bring resistance values over the minimum reading required.

TESTING AT TEMPERATURES OTHER THAN 40° C.

Insulation resistance of most insulating materials is effected in inverse proportion to the temperature. This means that a lower insulation resistance value will be obtained when a motor is tested at operating temperature than if the motor were cold. To minimize the effect of temperature when considering the recommended minimum value, it is important to correct the test results to a 40° C. base. The following formula, in accordance with IEEE No. 43 will provide this correction.

$R_{40C} = K_t \times R_t$

Where:

R_{40C} = Insulation resistance (in megohms) corrected to 40°C.

R_t = measured insulation resistance (in megohms).

K_t = Temperature coefficient of insulation resistance for the temperature of the winding at the time test was performed.

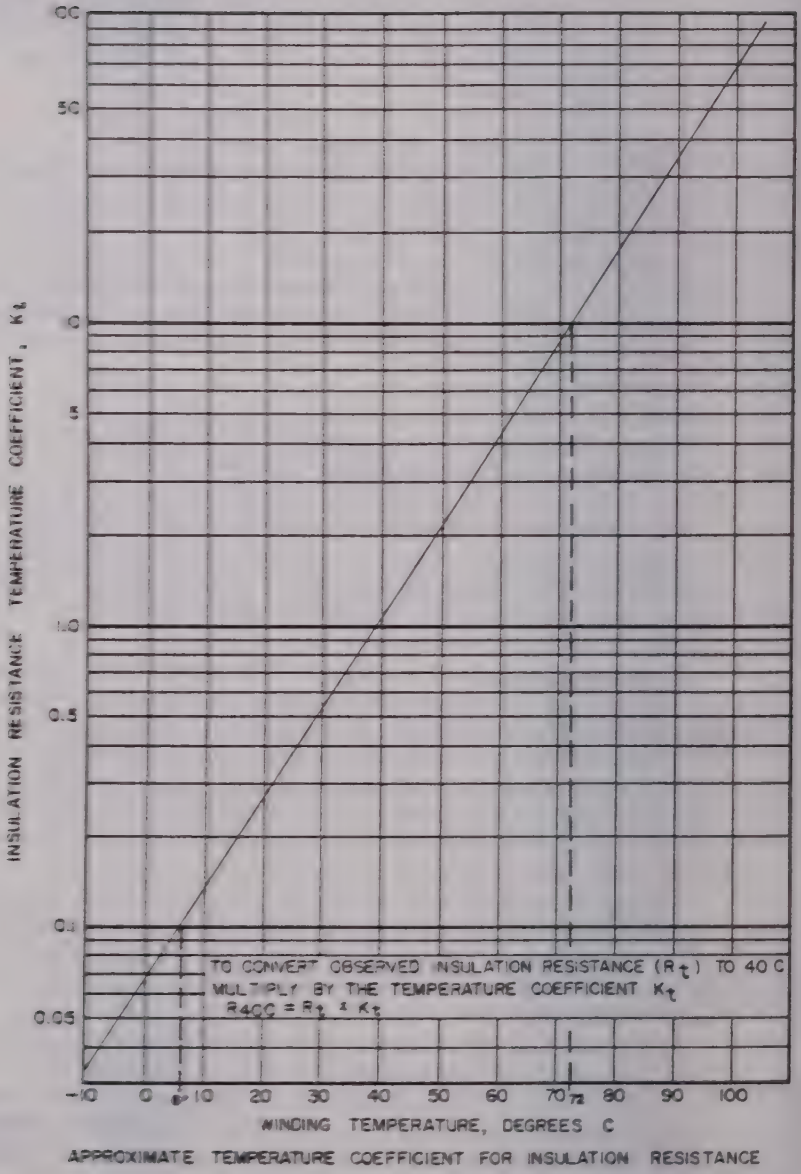
The graph (Figure 3) will provide an approximate value for the temperature coefficient. This graph is based on doubling the insulation resistance for each 10° C reduction in temperature and has been found typical of new windings.

For example: an insulation resistance test is performed on a motor at a temperature of 6° C. and the measured insulation resistance (R_t) is 100 megohms. Referring to the graph it can be seen that at a temperature of 6° C. the insulation resistance temperature coefficient (K_t) is approximately 0.1. If 0.1 is substituted for K_t in the formula and 100 substituted for R_t, then $R_{40C} = .1 \times 100$ or $= 10$. Therefore the 100 megohms resistance measured at 6° C would only be equivalent to 10 megohms at a temperature of 40° C.

In a similar example, let's assume that the measurement was made with a winding temperature of 72° C and the observed insulation resistance was 1 megohm. According to the graph the coefficient is approximately 10 and substituting this for K_t we have $R_{40C} = 10 \times 1$, or again a resistance of 10 megohms at a temperature of 40° C.

As you can see, the insulation resistance reading of 1 megohm at 72° C appears to be dangerously low until corrected for 40° C.

If greater accuracy is required, the temperature correction factor may be determined by making measurements at several temperatures while the windings are cooling, and the results plotted on a graph to make your own similar to that in (Figure 3).



APPROXIMATE TEMPERATURE COEFFICIENT FOR INSULATION RESISTANCE

Figure 3

WHERE AND WHAT TO TEST WHEN YOU START MEG-CHECKING

When you begin insulation resistance testing, every section of the current-carrying system should be isolated and tested, and a MEG-CHEK Record Card made of the test results. To define what constitutes a section of the current-carrying system, let us assume the simplest possible motor operating circuit to consist of power input wiring, a hand-operated, double-pole, single-throw switch, the wiring between the switch and motor, and the motor itself.

The power input wiring is part of the general system wiring and we will not consider it in this example. In order to keep the test sections as simple as possible we could consider the switch and the wiring from the switch to the motor as one section. Since the motor has several different circuits in which the insulation can fail we should keep the motor alone as the second section.

By keeping the test sections simple as possible, when trouble develops, it can be located more quickly. The extra effort necessary to disconnect and isolate these sections for testing will be repaid, for when weakened insulation shows up in a particular section, only two or three tracings may be required to pin down the potential trouble spot.

TEST WORKING EQUIPMENT FREQUENTLY

Working electrical equipment, such as motors, generators, transformers, heating elements, relays, etc., is much more likely to develop insulation failure than wiring, insulators and other non-cycling apparatus. Therefore, insulation resistance tests should be made more frequently on working equipment. Four to six months between tests is generally considered the safe maximum. Some users of the MEG-CHEK test all rotating machines every three months; and many motors operating in dirty or moist atmospheres are checked monthly. Annual testing of wiring is usually adequate...unless working conditions are particularly bad.

IMPORTANCE OF RECORD CARDS AND PERIODIC CHECKING

Unlike voltage, circuit resistance, or current flow, which can be determined positively at any time with proper instruments, "safe" insulation resistance values for any given type of equipment vary widely. For example, two motors of the same horsepower, same make, and same age, may have quite different insulation resistance values, yet both be in safe operating condition. Therefore, insulation resistance tests can do the best preventive maintenance job only when accurate test records are kept on each piece of equipment; and tests are made

at uniform intervals under similar conditions of operation, temperature and humidity to warn of a sudden change in insulation value.

MEG-CHEK Record Cards are included with each instrument (supplied with general purpose instruments only). One side of this card is a graph form, having space at the top to identify the device being tested. The graph's horizontal lines show MEG-CHEK resistance readings from tests taken at dates to be filled in across the top of the graph. The five columns across the card may each represent a year, or some shorter period, depending upon how often tests are made. By plotting each test on this graph, and joining the test reading points with a line, the history of the insulation resistance of that particular device is accumulated. Many MEG-CHEK users also draw a red line along the megohm value which they consider to be a safe minimum for each device, thus showing at a glance how close the readings are to the danger point.

On the reverse side of the MEG-CHEK Record Card are columns for recording pertinent data about the tests plotted on the graph. This information is important because it records the variations which occur in insulation resistance readings under specific conditions at the time tests are made.

PREDICT MOTOR FAILURE WITH PERIODIC INSULATION RESISTANCE TESTS

While the order of magnitude of the insulation resistance may give some indication of the condition of the equipment, of even greater importance is the change in resistance, particularly indication of an accelerated decrease in insulation resistance.

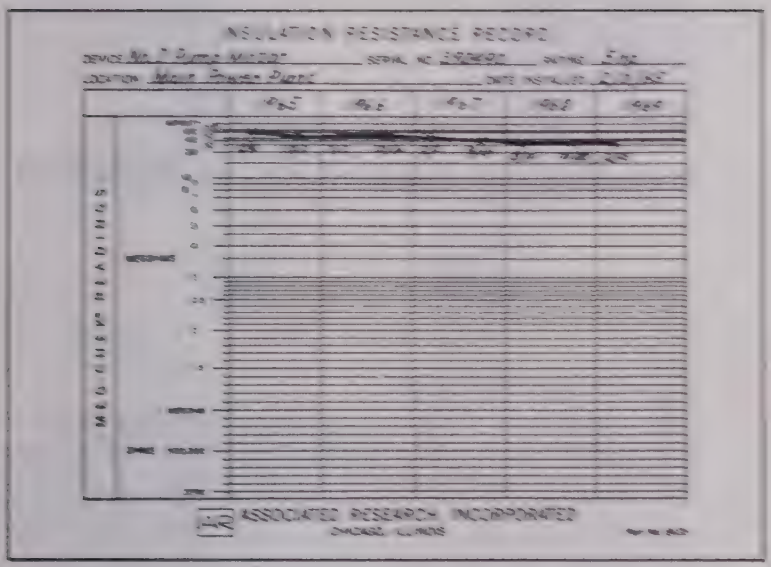
A simple system of record keeping for each piece of equipment will graphically indicate important changes in insulation resistance and allow a prediction of potential equipment failure.

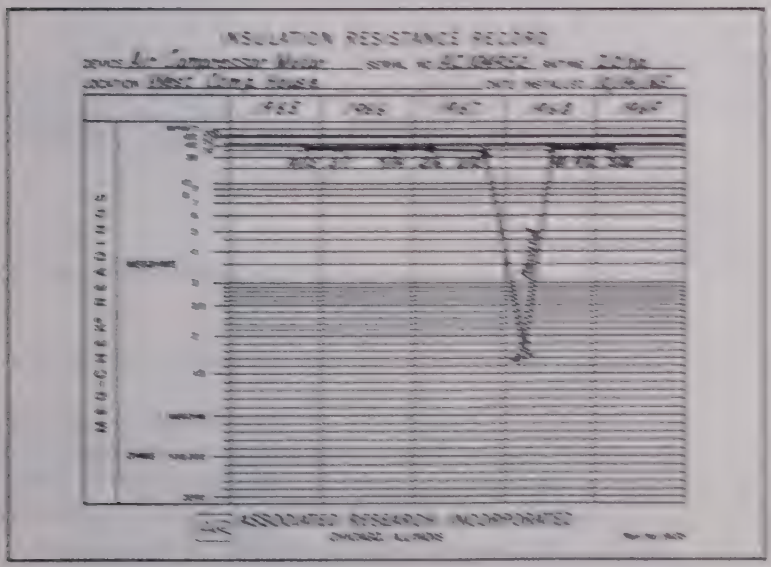
ARI record cards, as illustrated in Figure 4, are a convenient way to keep insulation records. The top card shows a normal aging insulation. Readings plotted show a gradual expected decrease in insulation resistance.

In contrast the record card below shows a sharp drop in insulation resistance— a warning that insulation is about to fail. Inspection showed a need for new stator windings which were installed during scheduled down time before the unit shorted out under load.

An envelope containing 10 record cards is supplied with each MEG-CHEK instrument. Additional Record Cards are available in sets of 10. When ordering specify Part 8435.

Figure 4


INSULATION RESISTANCE RECORD
MEGOHMMETER READINGS
ASSOCIATED RESEARCH INCORPORATED


INSULATION RESISTANCE RECORD
MEGOHMMETER READINGS
ASSOCIATED RESEARCH INCORPORATED

MEG-CHEK

Insulation Resistance Testing

PREPARATION FOR A TEST

Take equipment or circuits to be tested out of service. Check between the equipment terminals and ground using MEG-CHEK voltage ranges to be sure there is no voltage present. If possible, disconnect all leads to unit to be tested. Where a motor or circuit is not completely isolated, make sure you know of all the components which will be tested when you connect the MEG-CHEK. Should you overlook an interconnected circuit, the MEG-CHEK reading may be lower than expected.

MEG-CHECKING SPECIFIC EQUIPMENT

While the basic principles of Insulation Resistance Testing are the same for all types of equipment, the following diagrams and brief descriptions will show you how to determine insulation resistance quickly and easily for various types of electrical equipment.

WIRING

Testing of wiring can be performed on all types of systems if you keep two rules in mind:

1. Be sure your wiring is de-energized.
2. Know what wiring is included in the test...and make a record card of it.

Where you have a distribution panel, check the entire system to ground by attaching one MEG-CHEK lead to the dead post of the open main power switch, and the other lead to grounded conduit. (Figure 5)

Individual circuits are tested to ground by opening distribution panel switches or fuses and testing each circuit in turn (Figure 5 shaded lead).

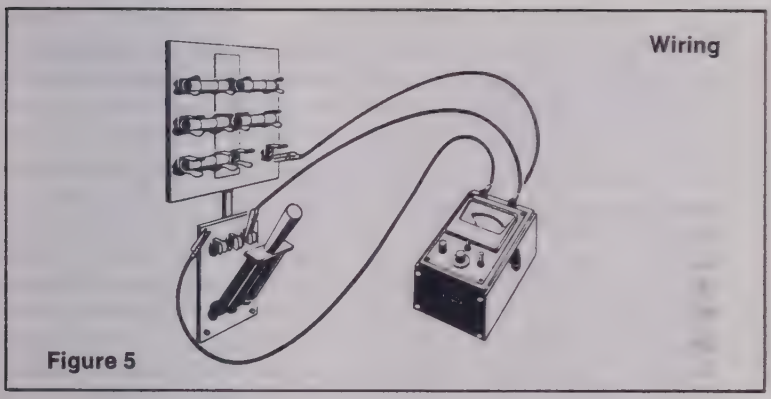


Figure 5

Multi-conductor cables may be tested in any of the ways shown in (Figure 6). The drawing depicts the measurement of insulation resistance between wire (3) and lead sheath (5). Various other measurements can be made such as wire to ground (1, 2 and/or 3 to 6), wire to wire, (1, 2, or 3 to any combination of each other), wire to braid (1, 2 or 3 to 4), wire to sheath (1, 2 and/or 3 to 5).

It is well to remember that when you test wiring which is connected to any panel or equipment, there may be appreciable leakage between terminals which will show up in your tests as lowered insulation resistance. If your original record cards were made with panels connected, continue future test, in the same manner.

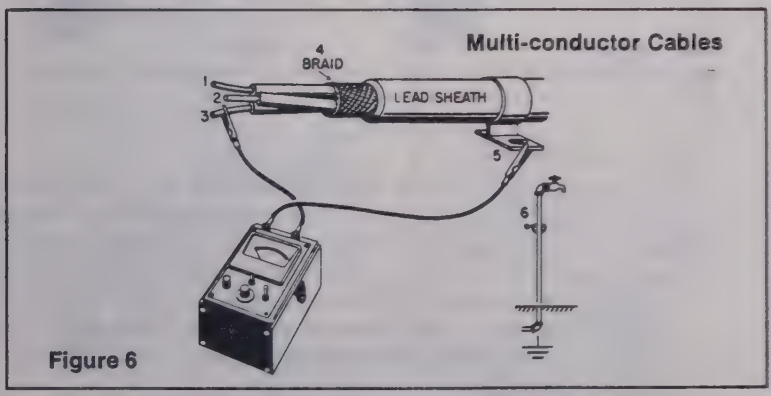


Figure 6

DC MOTORS AND GENERATORS

Disconnect unit from its power source or load and attach the negative test lead of the MEG-CHEK to machine ground and the positive lead to the brush rigging. Measuring the insulation resistance in this manner indicates the overall resistance of all components of the unit.

To measure the insulation resistance of the field or armature alone, either remove the brushes or lift them free of the commutator ring and support them by means of a suitable insulator. Connect one MEG-CHEK test lead to the frame ground and the other to one of the brushes. Insulation Resistance of the field alone will then be indicated. (See Figure 7). With the brushes still removed from the commutator ring, connect one of the MEG-CHEK test leads to one of the segments of the commutator and the other to the frame ground. The insulation resistance of the armature alone will then be indicated. This test may be repeated for all segments of the commutator.

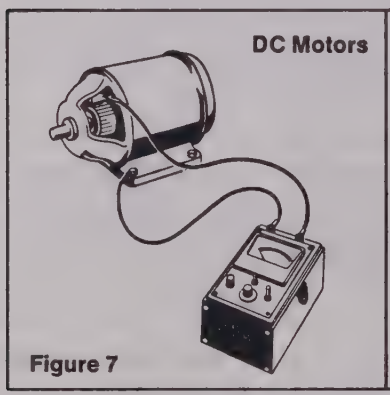


Figure 7

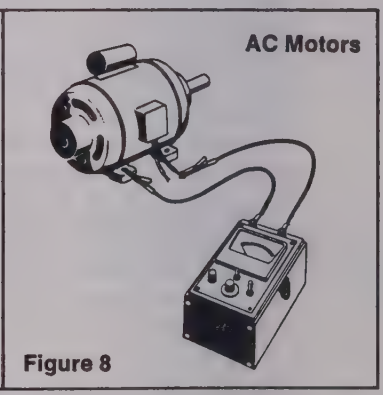


Figure 8

AC MOTORS

First disconnect the motor from the line, either by use of the switch or by disconnecting the wiring at the motor terminals. If the switch is used, remember that the insulation resistance of the connecting wire, switch panel and contacts all will be measured at the same time. Connect the positive MEG-CHEK lead to one of the motor lines, and the negative test lead to the frame of the motor (Figure 8). If insulation resistance minimums have been established, your reading can be checked against them.

CIRCUIT BREAKERS

Disconnect the circuit breaker from the line and connect the MEG-CHEK black lead to the frame or ground. Check the Insulation Resistance of each terminal to ground by connecting the red MEG-CHEK lead to each terminal in turn and making the measurements. Next open the breaker and measure the Insulation Resistance between terminals by putting one MEG-CHEK lead on one terminal and the other on the second, for a two terminal breaker, or for a three pole breaker, check between poles 1 and 2, 2 and 3, and 1 and 3 in turn.

If the breakers are of the oil type, dirty oil may cause leakage currents between the breaker contacts even when open. In dry types of breakers, dirt or grease in the mounting may cause leakage. Figure 9 depicts the measurement of insulation resistance between either circuit breaker terminal to ground. This measurement should also be made between terminals.

SWITCHES

Switches with safe insulation are a vital part of any electrical system, and so deserve your careful attention. Switches should be *completely* disconnected from line and relay wiring before testing. Where manual switches (Figure 10) are being tested, measure insulation resistance from ground to terminals, and between terminals. When you are testing electrically-operated switches, check the insulation resistance of the coil or coils and contacts. For coils, connect one MEG-CHEK lead to one of the coil leads and the other to ground. Next, test between coil lead and core iron, or solenoid element.

If relays are involved, measure insulation resistance with one lead connected to the relay plate or contact, and the other test lead to the coil, core or solenoid contact.

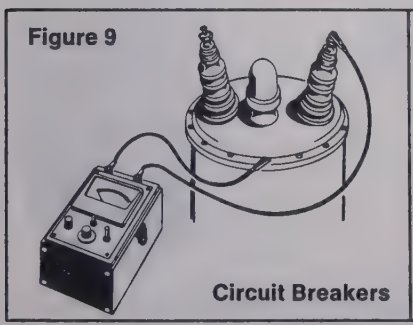


Figure 9

Circuit Breakers

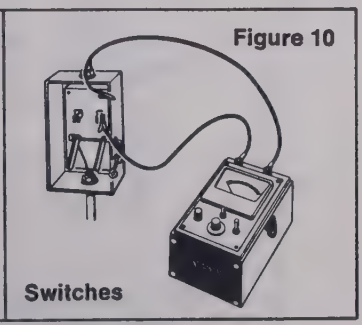


Figure 10

Switches

Although these suggested tests may appear to be excessive in view of the usually superior performance of most switches over long periods of time, these recommendations are made with knowledge that one inoperative closed switch may literally wreck a whole plant system. Thorough testing can help to insure against such an occurence.

INSULATORS

Insulators are subject to several conditions that can make them a potential hazard unless they are periodically tested. Breakage is probably the greatest hazard with insulators; others are accumulated dirt, grease or liquids. Sometimes, faulty construction makes a new insulator a source of danger but this is rare. Test each end of the insulator to ground. (See Figure 11) Where insulators do not have suitable electrical contacts, wrap the ends with foil and use the foil as the contact to connect to the MEG-CHEK test lead.

CAPACITORS

You can use your MEG-CHEK to measure insulation resistance of capacitors. Whenever you connect leads to capacitor terminals, observe polarity carefully. Allow enough time for capacitor to charge to maximum test voltage (until meter pointer stops moving upward) and record insulation resistance at highest reading. Be especially careful to *release the Lever Switch* before you disconnect test leads from capacitors. If you do not give the MEG-CHEK discharge resistor an opportunity to dissipate the stored potential in the capacitance, you may get a severe shock.

Insulators

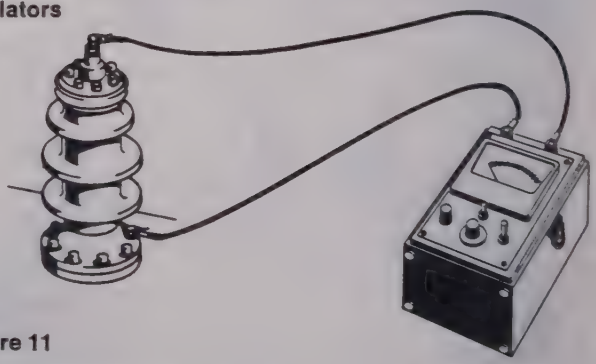


Figure 11

METERS

When measuring insulation resistance of meter movements to ground, first disconnect the leads from the meter terminals and connect the terminals together. Then connect the MEG-CHEK positive test lead to the meter terminals and the negative test lead to the Frame or other grounded part.

Meter movements are generally so delicate that if you suspect leakage between elements in the meter, it is best to remove the meter and have it checked by an instrument repair expert.

Watthour meter connections to terminal boxes should be checked after opening the power circuit and removing the meter from the box. Measure the insulation resistance between each terminal to ground and between terminals. Test for possible leakage.

APPLIANCES

Insulation resistance testing of all appliances at the factory is one of the most important single precautions against home accidents and merchandise returns due to short circuits, burn-outs, or circuit failures. (Figure 12) depicts the testing of a toaster. This same test can be performed on other appliances by connecting the test leads in a similar manner. Such testing, as part of final factory inspection of household appliances, prevents shipment of faulty units, saves considerable warranty expense, customer annoyance, or possible personal injury.

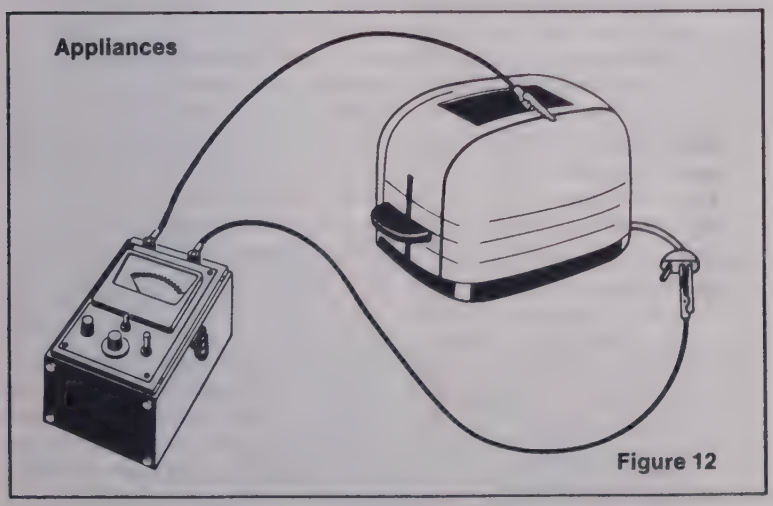


Figure 12

TRANSFORMERS

Disconnect leads from both primary and secondary windings. Tests can be performed on either winding by connecting the MEG-CHEK negative test lead to an associated ground (case, metal mounting, or man-made ground), and the positive test lead to the winding to be measured.

Insulation resistance should then be measured between the windings themselves. This is accomplished by connecting one test lead to the primary (either lead); and the second test lead to the secondary. All such tests should be recorded on the MEG-CHEK Record Card under proper identifying labels.

PASS/FAIL VALUES

Exact standards for determining acceptable measurement results vary considerably. Though values can be derived from formulas, we suggest contacting the original equipment manufacturer for his recommended testing procedures and limitations. Most manufacturers will gladly send you specification sheets and information on their products, giving factors you must take into account. Cable manufacturers will provide the same service, though on certain types of cable the information is available from standard publications on the subject.

FLOODED EQUIPMENT

When electrical equipment is watersoaked—either by flood waters or accidental wetting—you are fortunate indeed when you have MEG-CHEK Record Cards on the equipment. First, clean and dry the equipment to the best of your resources. Then, depending upon what has been flooded, begin the recommended electrical or mechanical drying-out procedure. Progress of dryout may be observed by means of one minute insulation resistance readings, but these readings should be corrected to 40° C. Make the first test and record it on a new Record Card which is "red-lined" at the insulation resistance value you last read from your MEG-CHEK before wetting occurred. If the initial reading is below the safe minimum insulation resistance, continue the dryout procedure, taking readings at regular intervals, until the insulation resistance is approximately equal to the previous dry value. After this point has been reached, it will be safe to return the equipment to service, provided that the last "dry" reading indicated safe insulation resistance. Wetting of any kind, serious enough to require unusual drying measures, should be recorded on the permanent Record Card of the equipment effected, and the "Drying-Out Card" kept on file for reference.

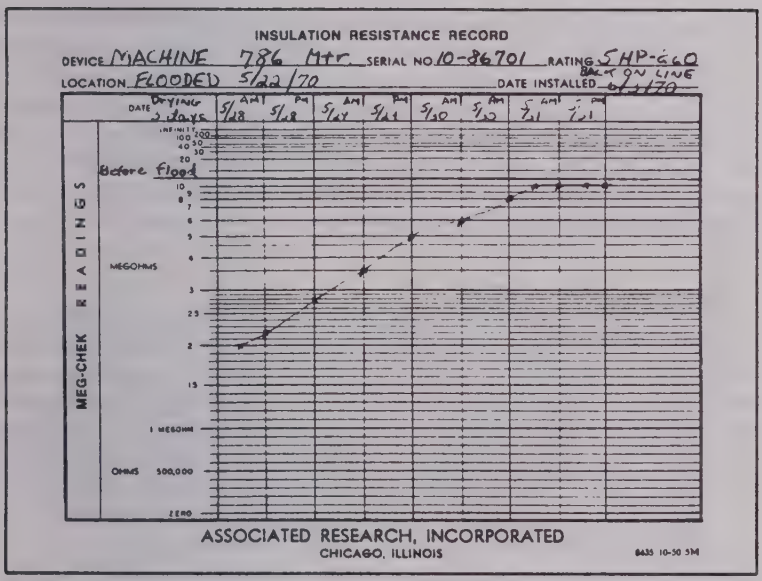


Figure 13 **FLOODED EQUIPMENT TESTING**

Where no previous MEG-CHEK Record Card has been made on flooded equipment, readings should be made at intervals during the drying-out procedure until a definite "plateau" occurs in the insulation-resistance value line on the card. Such a line is plotted as shown in (Figure 13). After the plateau stage of drying-out has been reached, Polarization Index* tests should be made until an Index of 2.0 or more has been reached. If this Polarization Index cannot be reached, repair or overhaul is indicated.

NETWORK TESTING

Network Testing—when adequate MEG-CHEK test records are available—provides a quick method of determining the serviceability of the system.

First isolate and check the individual components that make up the system to determine that each has a safe insulation resistance value. Then reconnect the components and test each main circuit, recording the insulation resistance value of each circuit (with its various components connected). Finally test the whole system from a main distribution point and record that value. With this basic insula-

*See page 24

tion resistance information on Record Cards, you will be able to check the entire network at frequent intervals without the necessity of disconnecting each piece of equipment. Only when a significant lowering of the network insulation resistance appears will it be necessary to test individual circuits and units to locate faulty equipment. The insulation resistance, when compared with previous measurements, denotes the condition of the network and indicates if any segment is defective and should be isolated for maintenance.

INSPECTION TESTING

Insulation resistance testing of hundreds of different components in industry has resulted in setting up standards in inspection testing to protect manufacturers from the shipment of defectively-insulated products. Using the MEG-CHEK as an inspection testing instrument does not vary in any respect from regular preventive maintenance tests, except that use of the MEG-CHEK is usually almost continuous—and generally in one place. Continuous testing of this kind has proven MEG-CHEK's durability under severe service conditions.

DIELECTRIC ABSORPTION

Dielectric absorption, a characteristic of electrical insulation, may be considered the "soaking up" of electrical current by the insulation being tested. When making standard 60-second tests, you will note that the meter indication gradually increases during the test. This is due to dielectric absorption combined with capacitance charging of the apparatus being tested.

Dielectric absorption characteristics may be used to advantage to appraise the cleanliness or dryness of a winding by performing a polarization index test as described below.

POLARIZATION INDEX

Polarization index testing is a useful means of determining if equipment is suitable for operation or even for an overpotential test. Polarization index is the ratio of the insuiation resistance value at the end of a ten minute test to the value at the end of a one minute test. If the equipment is in good condition the insulation resistance reading will usually be considerably higher at the end of ten minutes than at the end of one minute because of the dielectric absorption characteristics of the insulation and the effect of the capacitance of the apparatus. When the insulation has absorbed maximum current and the capacitance has charged to maximum test voltage, the total current flow is

less and the observed insulation resistance is due, primarily, to the leakage current through and over the surface of the insulation.

In the case of a wet or dirty insulation system, moisture and dirt on the insulation tends to greatly increase the leakage current and, as a result, absorption and capacitive currents become a smaller percentage of the total, thus masking their effect. At the end of a ten minute test under such conditions, insulation resistance indication may very well be the same as that at the end of a one minute test. This would indicate a polarization index of 1.0 which is below the recommended minimum.

To perform a polarization index test, connect the MEG-CHEK as described for an insulation resistance test and start timing when the lever switch is operated to TEST. Record the insulation resistance indication at the end of one minute, but continue to hold the lever switch in the TEST position until ten minutes has elapsed. Record the insulation resistance indication at the end of ten minutes. Divide the second reading by the first reading and the result will be the polarization index.

In accordance with IEEE No. 43, the recommended safe minimum value is 1.5 for an insulation rated for 105° C. and 2.0 for an insulation rated for 130° C., provided that the insulation resistance indication for one minute is above the recommended minimum for insulation resistance testing.

Temperature correction is not necessary for a polarization index test. However, if the one minute reading is to be recorded on the Record Card for information, or if this reading must be used to determine the safe minimum value, then correction for 40° C. must be applied.

Depending on the equipment and various other conditions, polarization index values of 1 to 10 are frequently obtained, while values of 2 to 5 are quite common.

MEG-CHEK Maintenance

The pointer on your MEG-CHEK meter should rest directly over the ∞ mark at the extreme left of the scale. If the pointer is not in this position, carefully turn the set screw in the center of the meter cover until the pointer is properly positioned.

BATTERIES

Your MEG-CHEK is powered by two 1.5 volt dry cells (Burgess, 4FH, Eveready 735, or equal) connected in series to deliver 3 volts DC to the instrument circuit. Until the voltage output of the batteries drops to approximately 2 volts, you will be able to zero the meter and make tests with full accuracy. When you cannot adjust zero, it is time to replace the batteries.

Remove screws A-A-A-A (Figure 1) on the sides of the top flange surrounding the panel of the instrument and lift out the entire panel assembly, (including the protective cover over the instruments' components under the panel, and the battery holding brackets) as shown in Figure 14 . The batteries are held in place by a clamp plate secured by thumb nuts (5).

Remove the thumb nuts, clamp plate and batteries (4). Disconnect wires to the batteries and connect them to new batteries in identical pattern. Be sure to observe the polarity shown on diagram (1). The red wire from the instrument goes to the + post of one battery; the black wire to the − post of the other battery. The short jumper wire connects the two remaining posts (+ to −).

Replace batteries in the holder and clamp down, making certain that the battery posts are oriented as shown in Figure 14 .

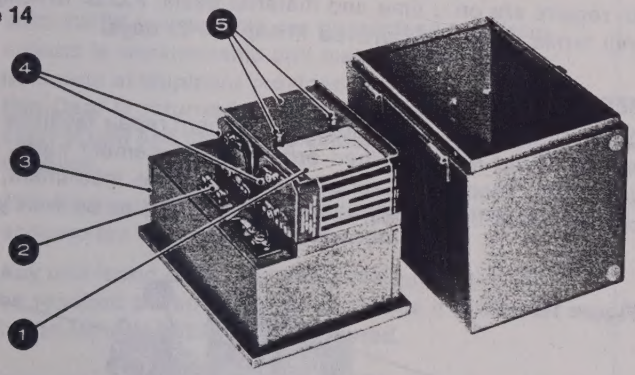
Replace the panel assembly with the A-A-A-A screws.

FUSE

Some MEG-CHEKS are equipped with a fuse to protect the circuitry against inadvertent application of voltage when measuring insulation resistance (megohms) or circuit resistance (ohms). Should this fuse open, the instrument will be rendered inoperative on all ranges, including Voltage Ranges.

To replace the fuse, remove the panel assembly and protective cover as explained under battery replacement above. The fuse is mounted in a clip (Figure 14) near the terminal end of the batteries. Remove the open fuse and repiace with one of the same rating.

Figure 14



Battery compartment view of Model 2201 MEG-CHEK

1. Battery Connection Diagram
2. Fuse
3. Panel with Protective Cover
4. Batteries
5. Battery Clamp with Thumbnuts

ACCIDENTAL DAMAGE

Despite rugged construction throughout, your MEG-CHEK cannot take heavy blows, dropping, or shocks without possible damage to the meter movement or parts of the circuit.

Should you have the misfortune to damage your MEG-CHEK, the quickest and most economical way to get it repaired is to send it to:

Associated Research, Inc.

905 Carriage Park Ave.
Lake Bluff, IL 60044 U.S.A.

for repairs and prompt return. Pack the instrument carefully in carton or box, with enough excelsior, paper or other protective cushioning

to prevent damage in transit. For fastest service, ship prepaid by REA or Air Express, insured for full value.

Under separate cover, send letter and/or purchase order to Associated Research Incorporated giving the following information:

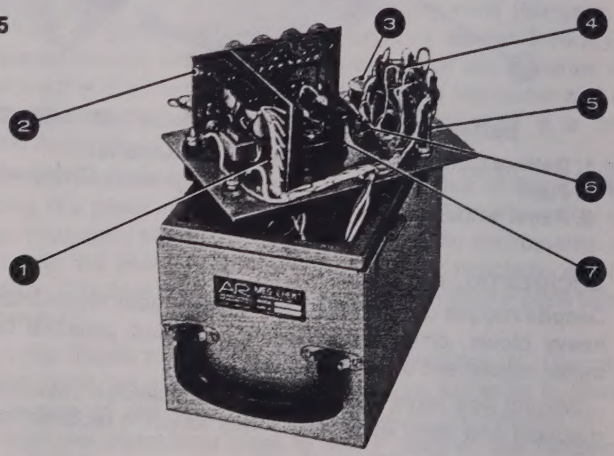
1. Model and Serial Number.
2. Defect noted.
3. When and how the instrument was or will be shipped (waybill number if possible).
4. Address to send invoice.
5. Address to return instrument.

All repairs are on a time and material basis, F.O.B. Chicago, Illinois, with terms to credit-approved firms, net 30 days.

REPAIR PARTS

Qualified and properly equipped instrument repair facilities may order parts for field repairs. When ordering replacement parts, be certain to include: Model and serial numbers of the instrument, date purchased...and if possible, return the old part to us with your order.

Figure 15



Under panel view of Model 2201 MEG-CHEK

1. Transistorized Power Supply
2. Printed Circuit Calibration Assembly
3. Zero Set Potentiometer
4. Range Selector Switch
5. Lever Key Switch
6. AC-DC Selector Switch
7. Meter

MEG-CHEK Warranty

MEG-CHEK instruments are guaranteed free from defects in workmanship and material for one year from date of shipment provided Owner's Registration Card is returned within fifteen days from receipt of unit and there is no evidence of tampering or abuse.

This Warranty does not cover tubes, batteries, or accessories not of our manufacture.

Any unit found defective under this guarantee will be repaired or replaced free of charge if returned to the factory PREPAID and insured.

ASSOCIATED RESEARCH, INC.

Instruments for measuring

- Insulation resistance... the MEG-CHEK®
- Earth resistivity... the VIBROGROUND®
- Ground resistance... the VIBROGROUND®
- High voltage breakdown, AC-DC... the HYPOT®
- Cable fault location... the HYJOULE®

MP MASTER
MA30052

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